Roman Pot Acceptance Summary

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BNL EIC Science Task Force Meeting

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Overview

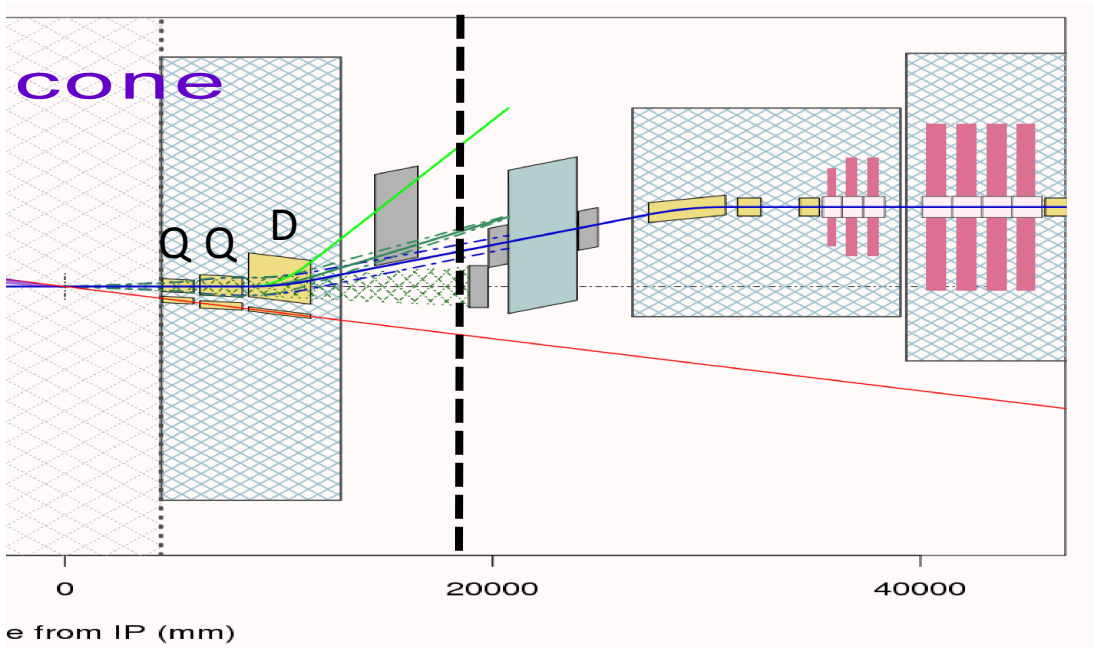
- Options galore
  - Linac-ring, versions 2.1 and 3.0
  - Ring-ring v1.1
- Some code changes to make this happen
- Results

Linac-Ring

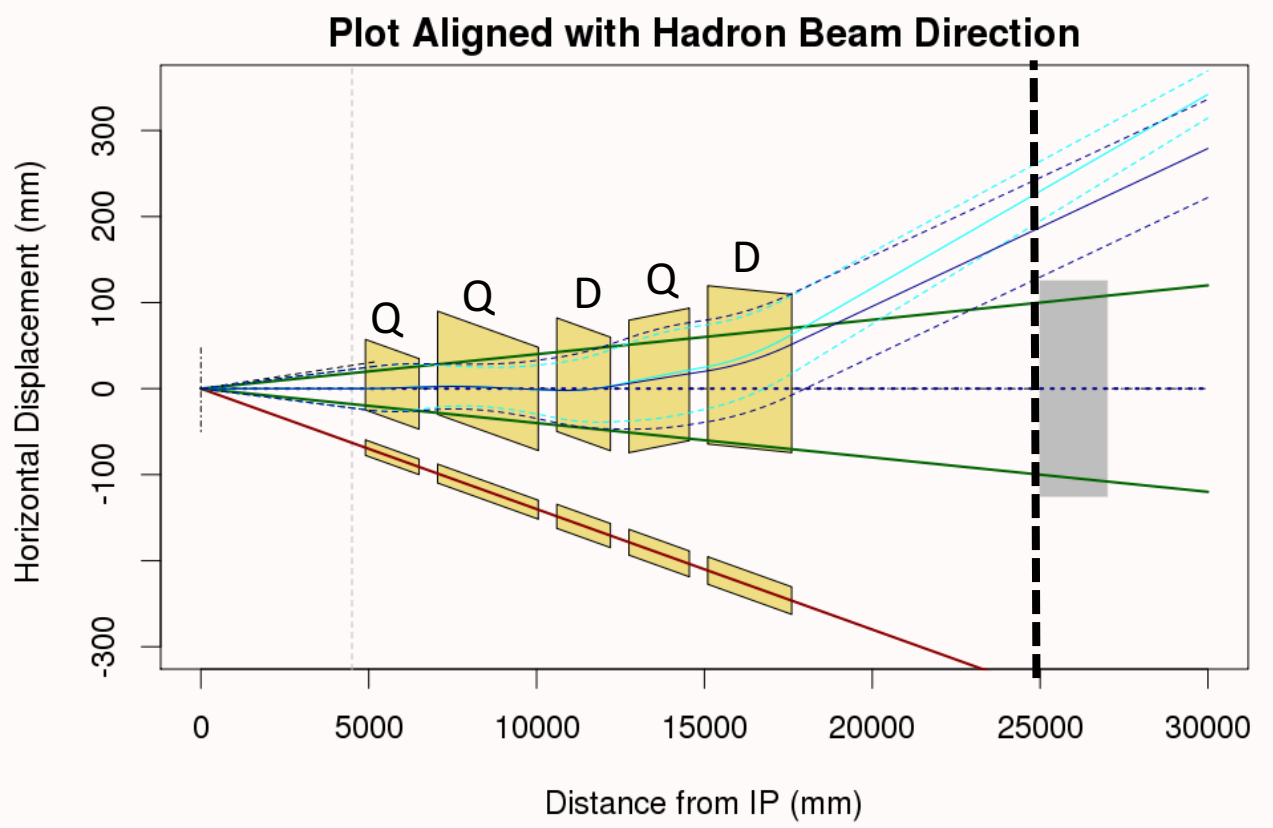
- Brett Parker is working on the linac-ring IR design
- He has addressed some of the issues that were raised on the old (v2.1) design in regards to the forward going proton acceptance
- Only developed the forward proton going side so far for v3.0
- Next slide shows a comparison of the two designs

Linac-Ring layout

v2.1

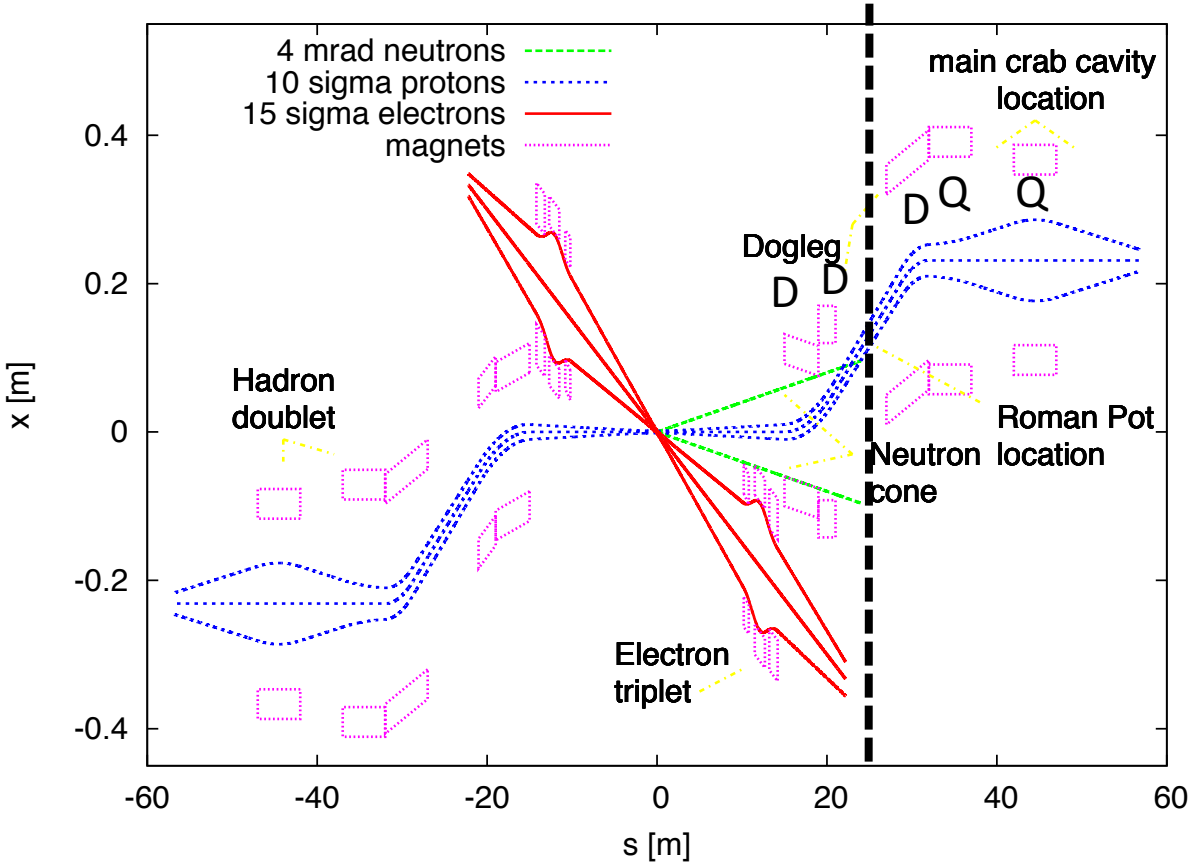


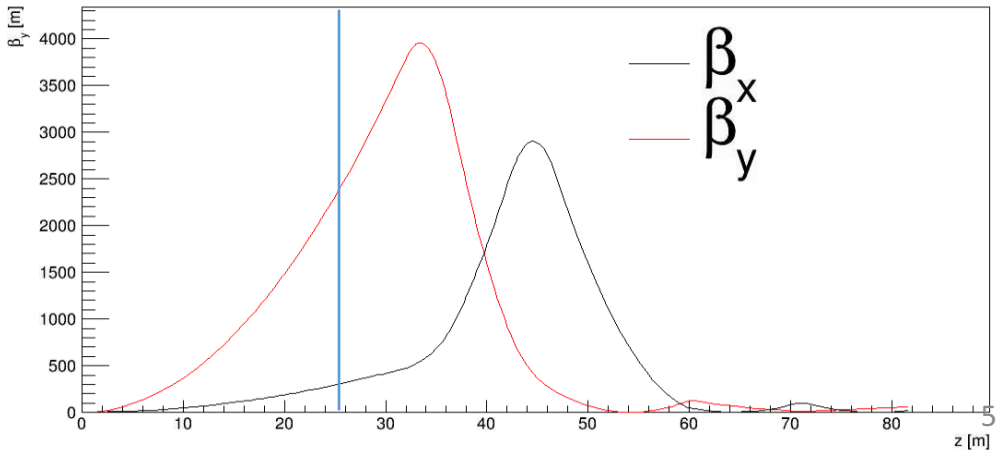
v3.0



Ring-Ring design

- Design by Christoph Montag
- One notable difference is that the hadron magnets are pushed back much farther from the IP (at ~15m compared to ~5m in linac-ring)
- Also beta function is much smaller in the location of the roman pots for this design
- (Robert Palmer working on yet another design)



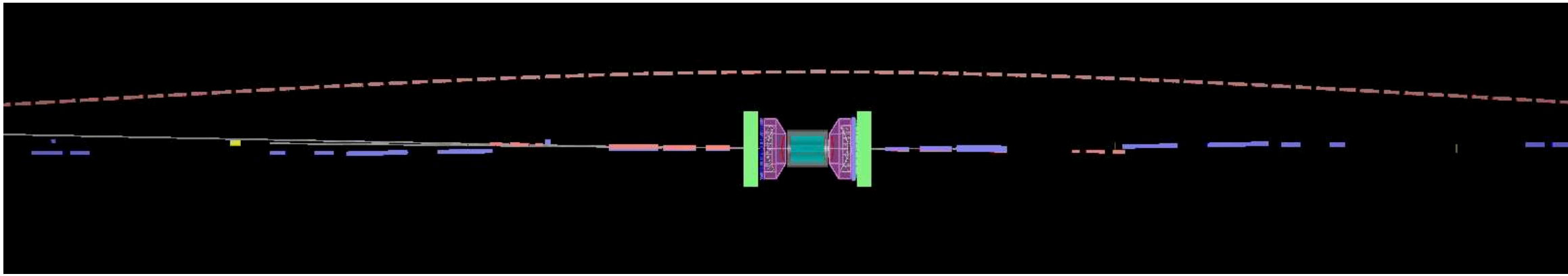


Code changes required

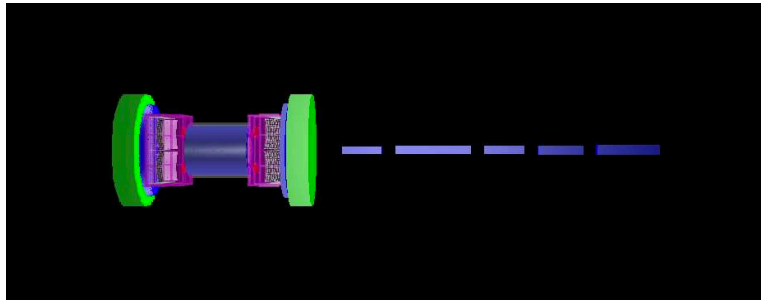
- Expanded classes in EicRoot to import and implement a new way of information transfer for magnets
  - Assumes perfect magnets (i.e. ignores edge fields, etc.) but is good for now
- Previously had a complicated procedure to produce field maps
  - In a single file, encoded magnet placement and a grid of field strengths
  - Each magnet had its own file
  - Terrible way, took multiple people in CAD to produce maps, resulting in us receiving only ONE design (though presumably more detailed information than now in use)
- New way is much simpler
  - Have a single file for each beam
  - One line for each magnet
    - Magnet_name center_z center_x center_y bore_radius rot_angle field_strength gradient
  - The field is calculated for each GEANT step directly from the coordinates
  - Will foster more collaboration and quicker iteration of design

IR layouts in EicRoot

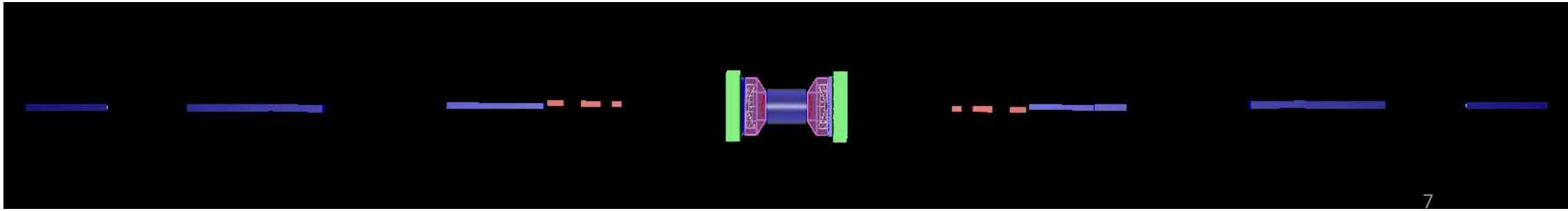
v2.1_
LR



v3.0_
LR



v1.1_
RR

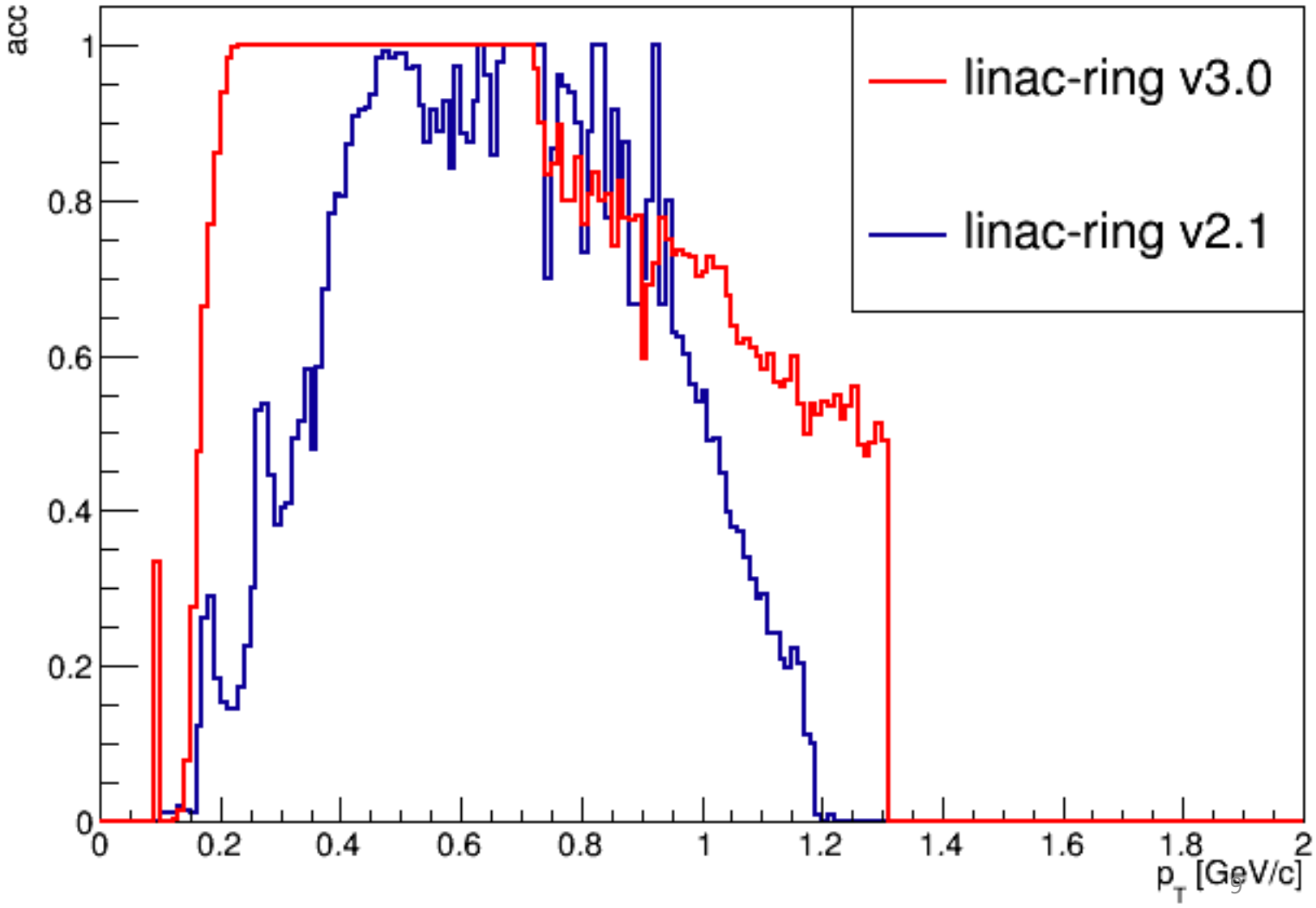


Acceptance plots for the roman pots

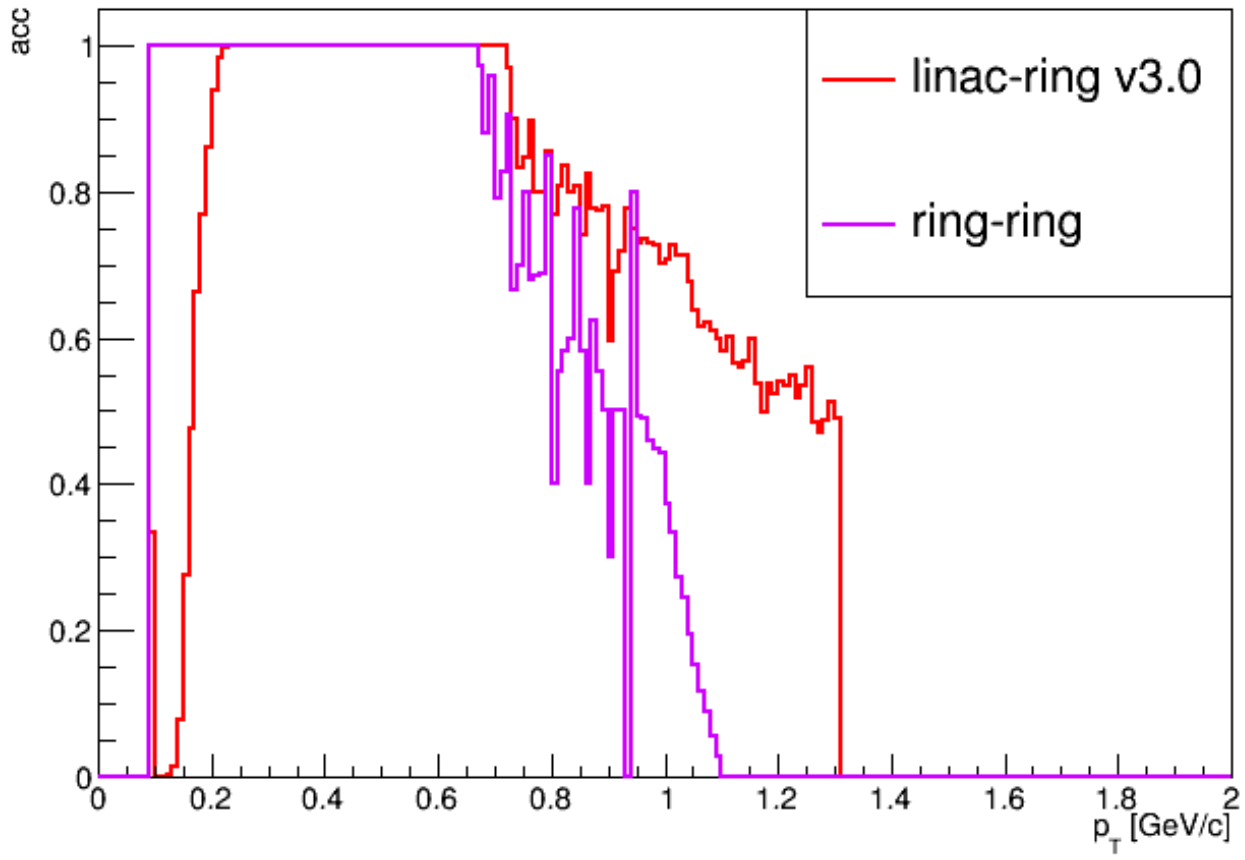
- All simulations use the identical MILOU simulation files of DVCS events
- All events originate from (0,0,0)
- Simulation does not account for beam divergence effects at the IP
- All simulations have the roman pots placed appropriately close to the beam
  - 10 sigma from the beam center calculated from the beta function in x and y
- Placement in z of the roman pot is adjusted for each case
  - 18m for linac-ring v2.1
  - 25m for linac-ring v3.0
  - 28m for ring-ring v1.1
- Simulations only have one beam line in place (sometimes the other beam line blocks path, this needs to be discussed with CAD)
- Neglected to place main detector solenoid – this can have some effect on protons with a larger angle

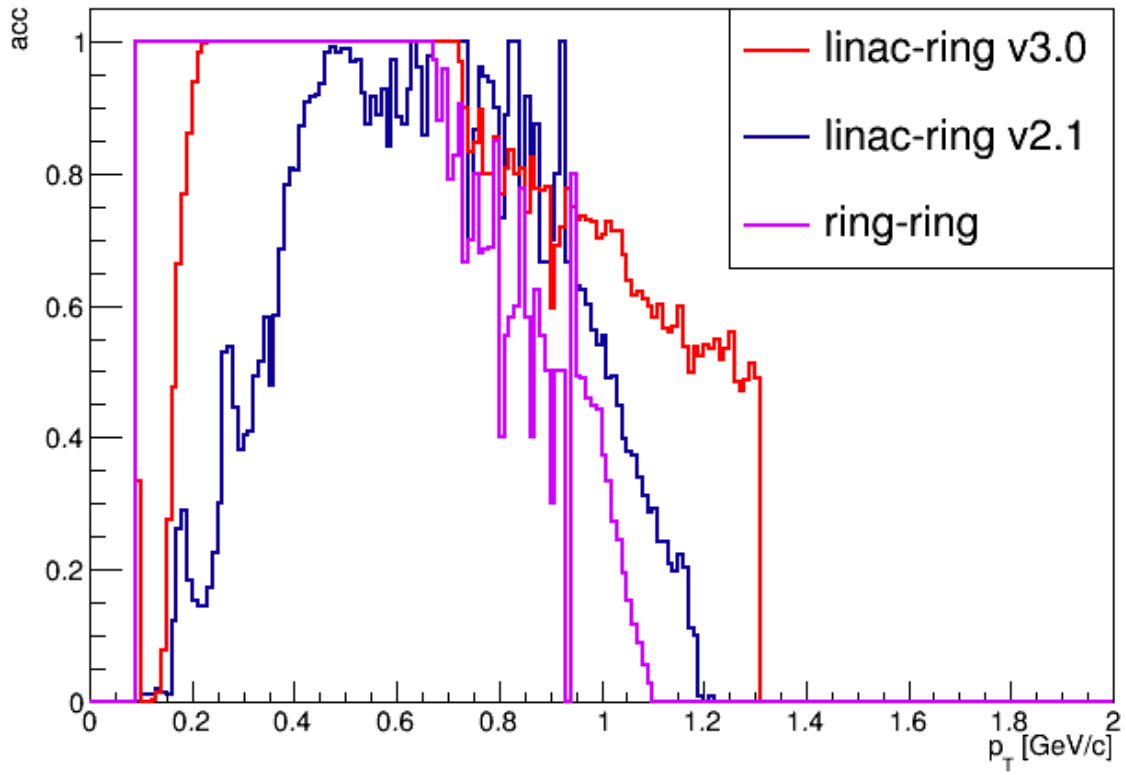
Linac-Ring Design – compare v2.1 and v3.0

- Still slight issue with alignment of magnets in v3.0
  - Neutral and proton lines of +4mrad does not make it through
- Acceptance is much improved!



Ring-Ring and Linac-Ring Comparison

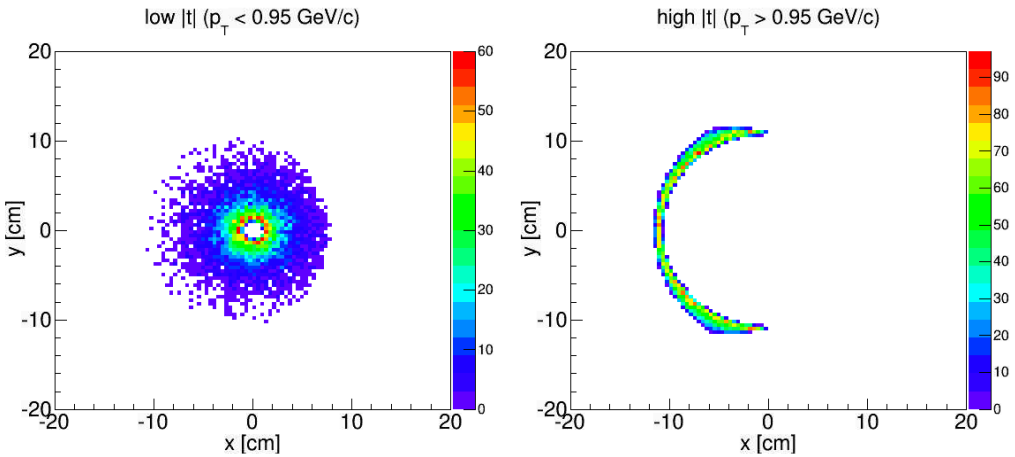




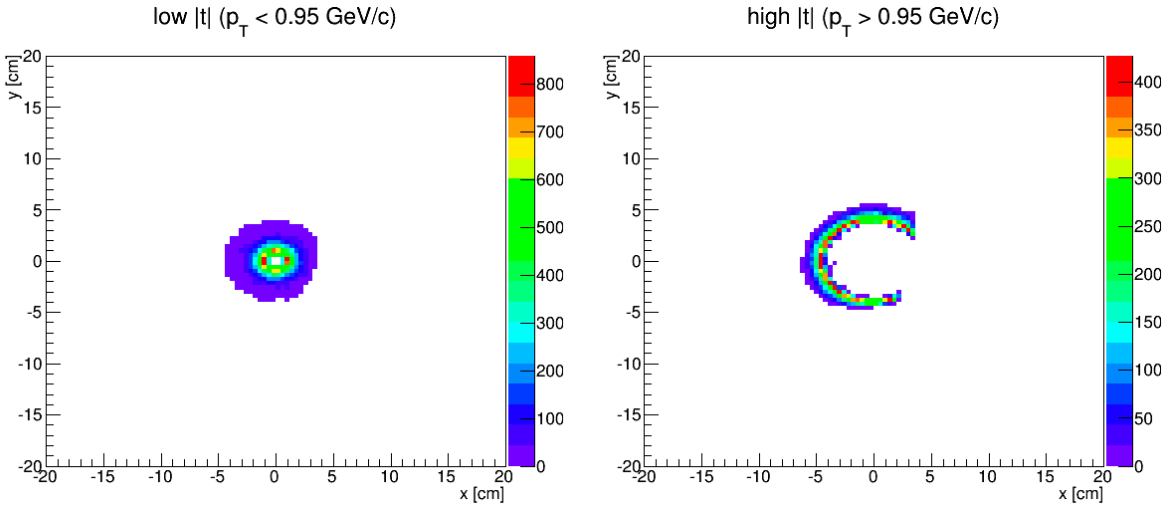
Hit maps on the roman pot for each design

- Lose protons that scatter to one side of the nominal beam line

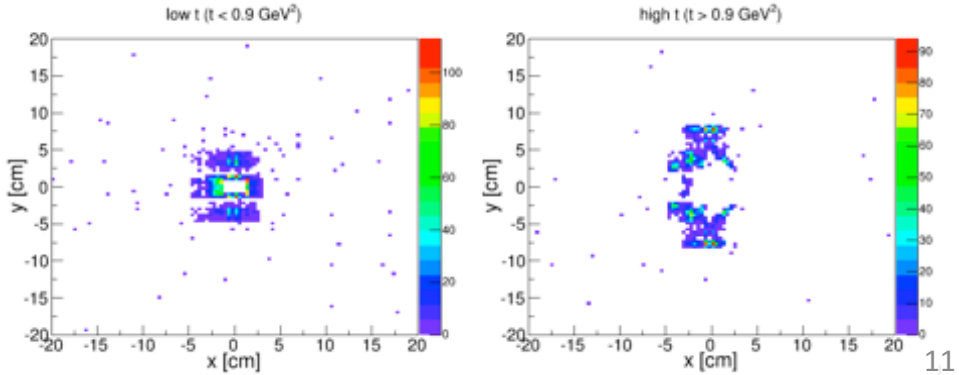
Ring-ring v1.1



linac-ring v3

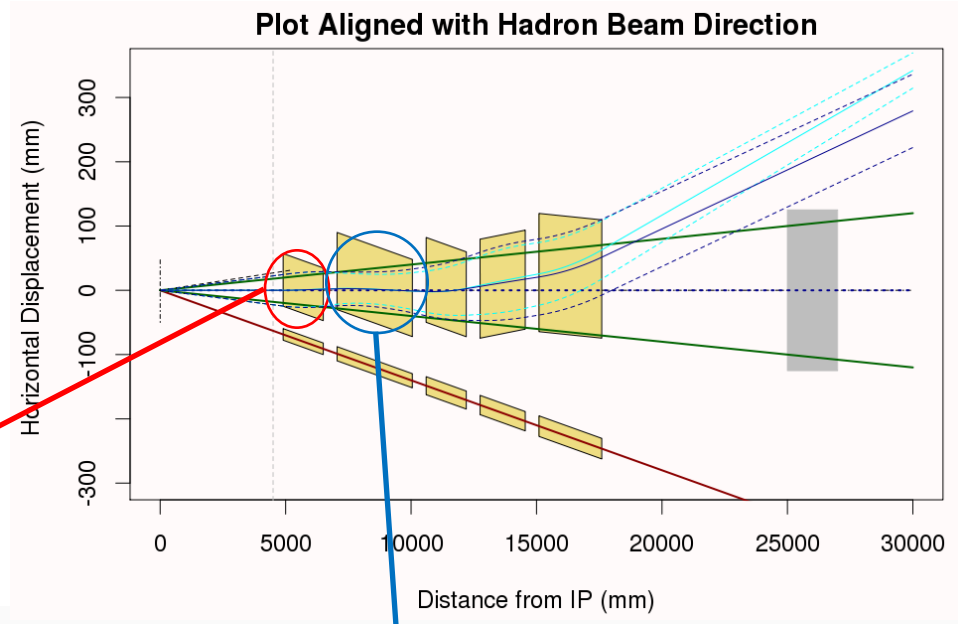


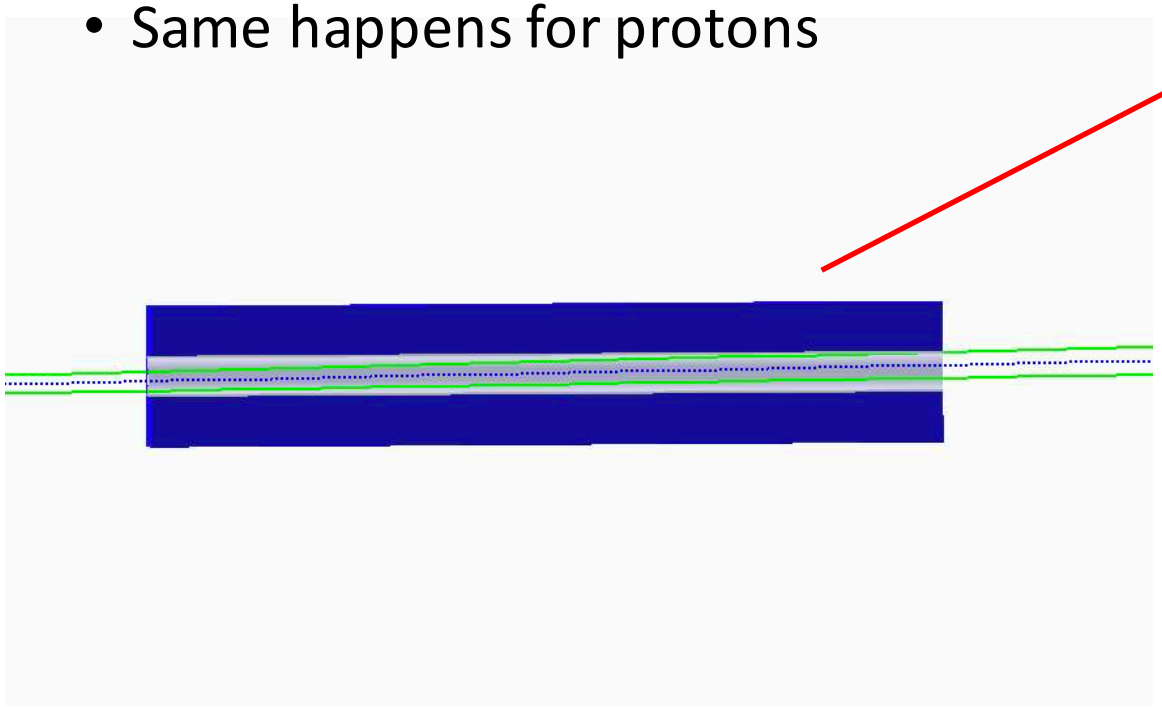
linac-ring v2.1

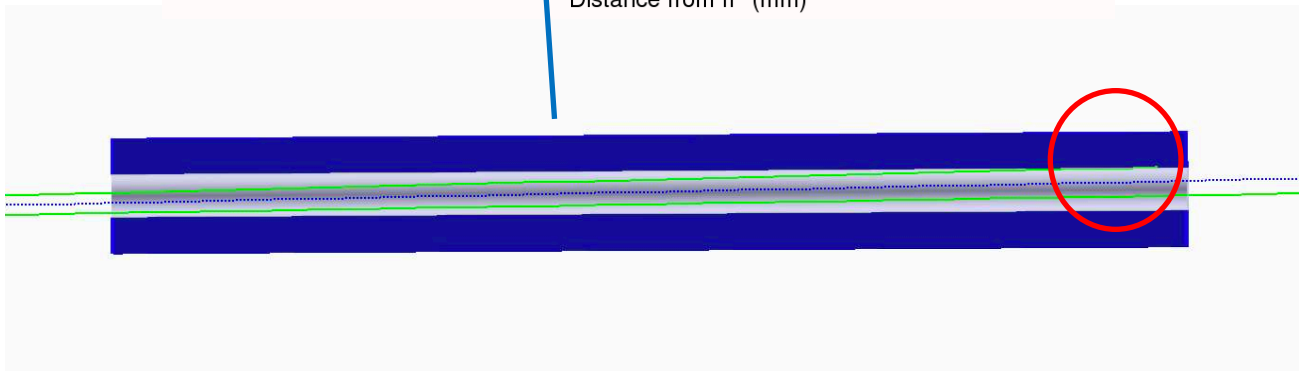


Still some issues – alignment problems?

- Evidence of some alignment issues for the linac-ring v3.0 design
- Green lines represent +/-4mrad neutron cone edges
- Line hits side of second quad
- Same happens for protons





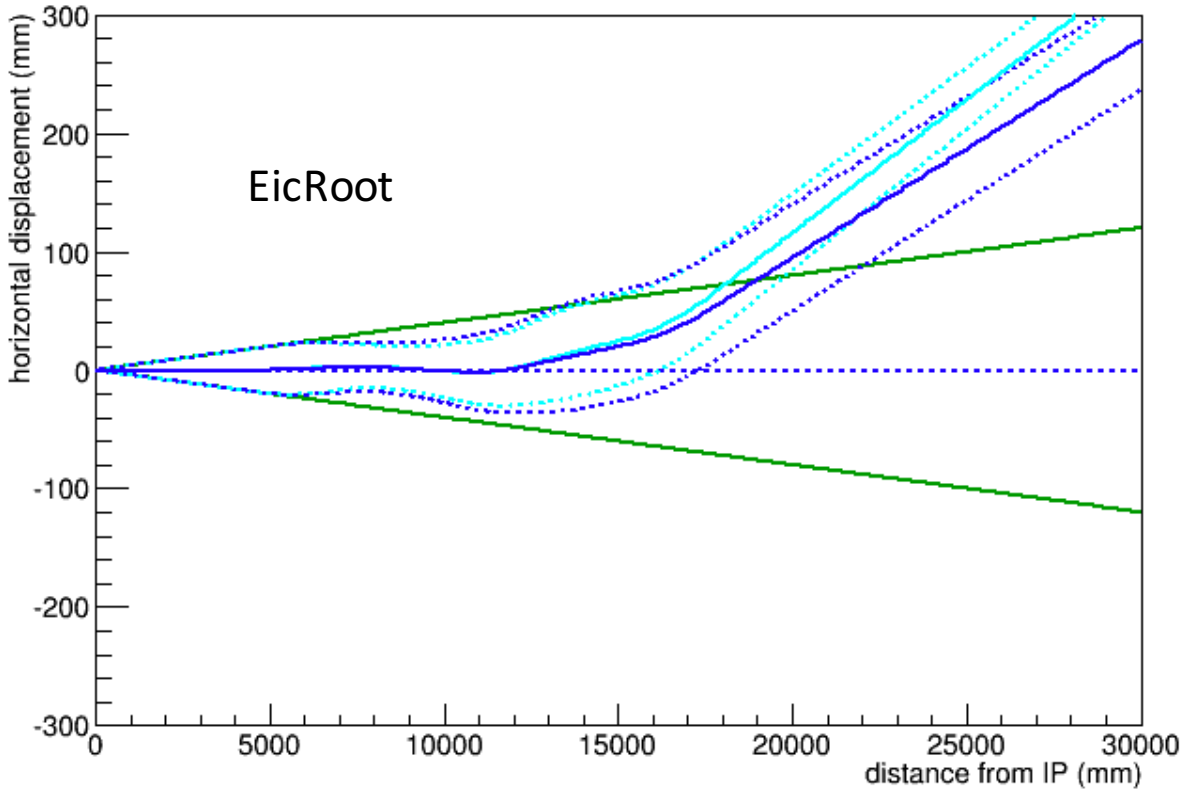


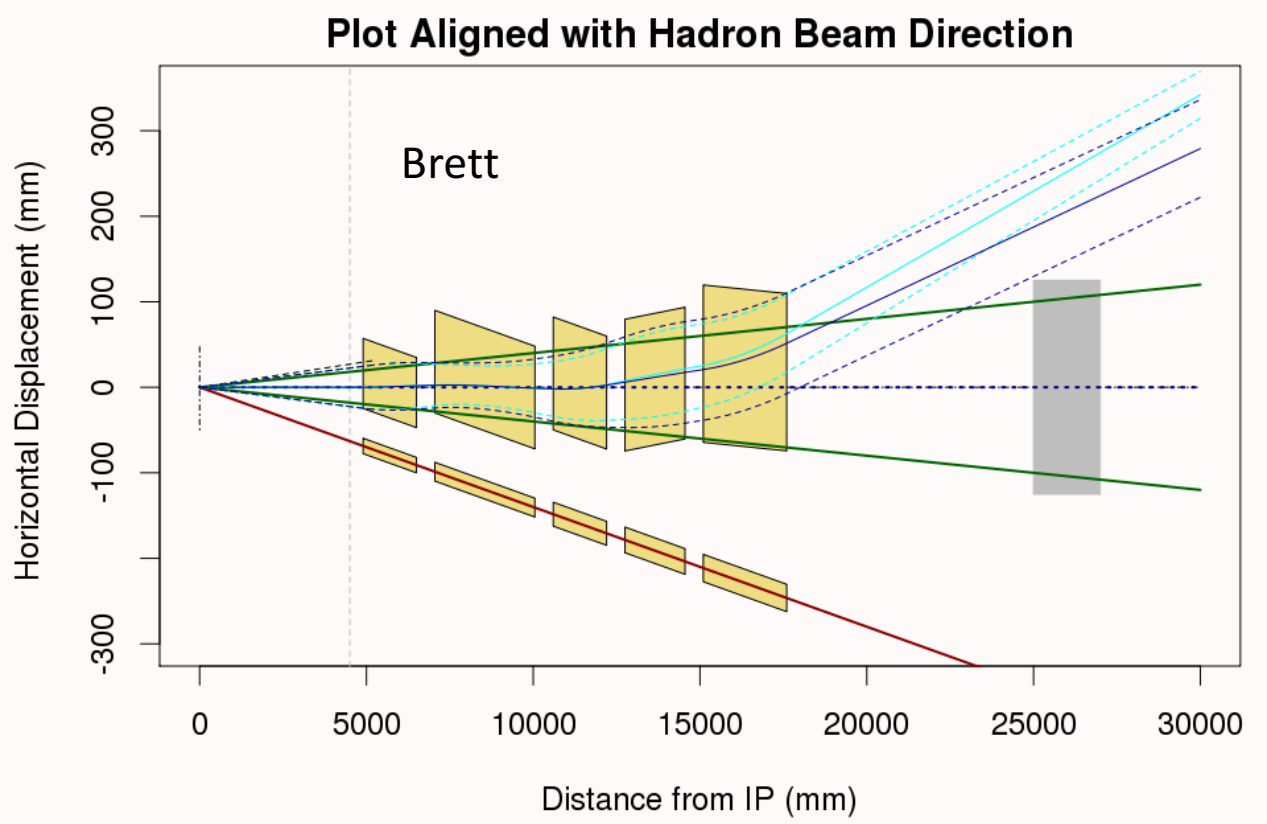
Problem found!

- After iteration with Brett, a couple of different errors occurred in unison
  - Brett made a mistake in the file he sent for v3.0. Displacement of the second quad in x was 6mm when it should have been 9mm
  - I made another (bigger) mistake due to a confusion on the format of the files
    - files was sent to me from Christoph and Brett still not in a common format (x, y, z position of magnet centers are swapped). I "fixed" this by hand in Brett's file, but screwed up the fix and ended up displacing in y instead of x. After this fix, the +/-4mrad neutral lines fit through the aperture perfectly as planned
- Combined with this fix, Brett handed me v3.01 of the proton lattice
  - Redid the optics matching when considering crab cavities
  - Gradients in the quads are slightly different

Better diagnostic procedure

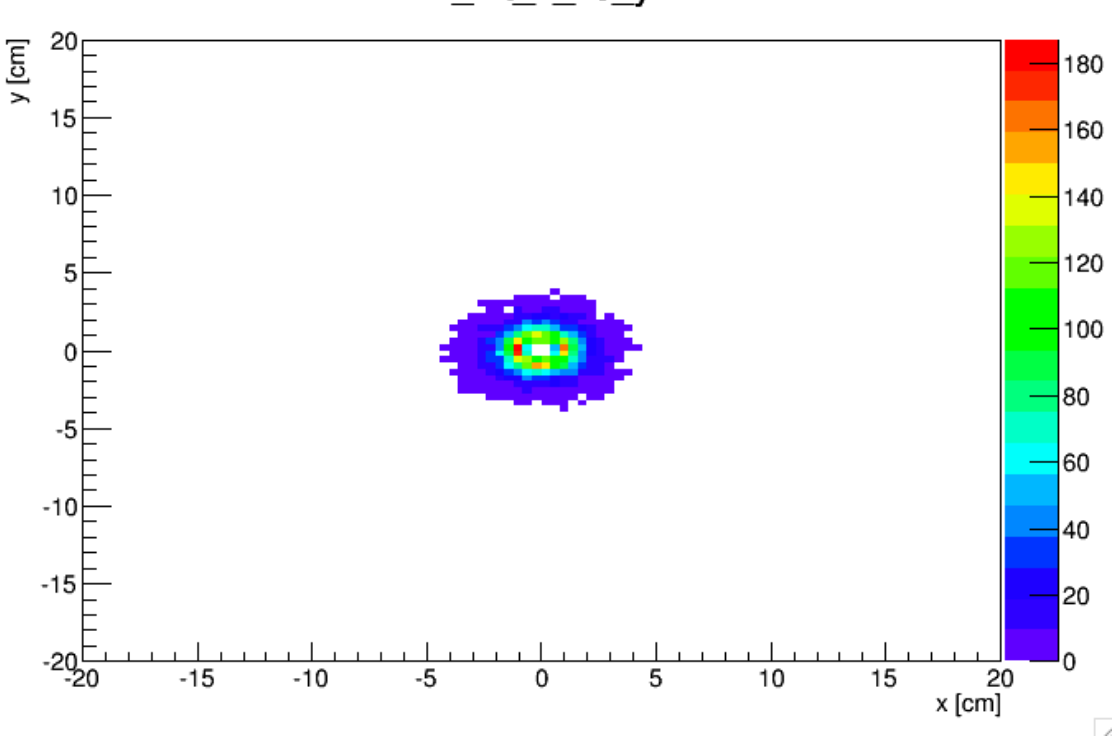
- to further convince us that the bugs are out, I reproduce Brett's IR plot from the tracking in the EicRoot simulation (removes effect of exaggerated scales)



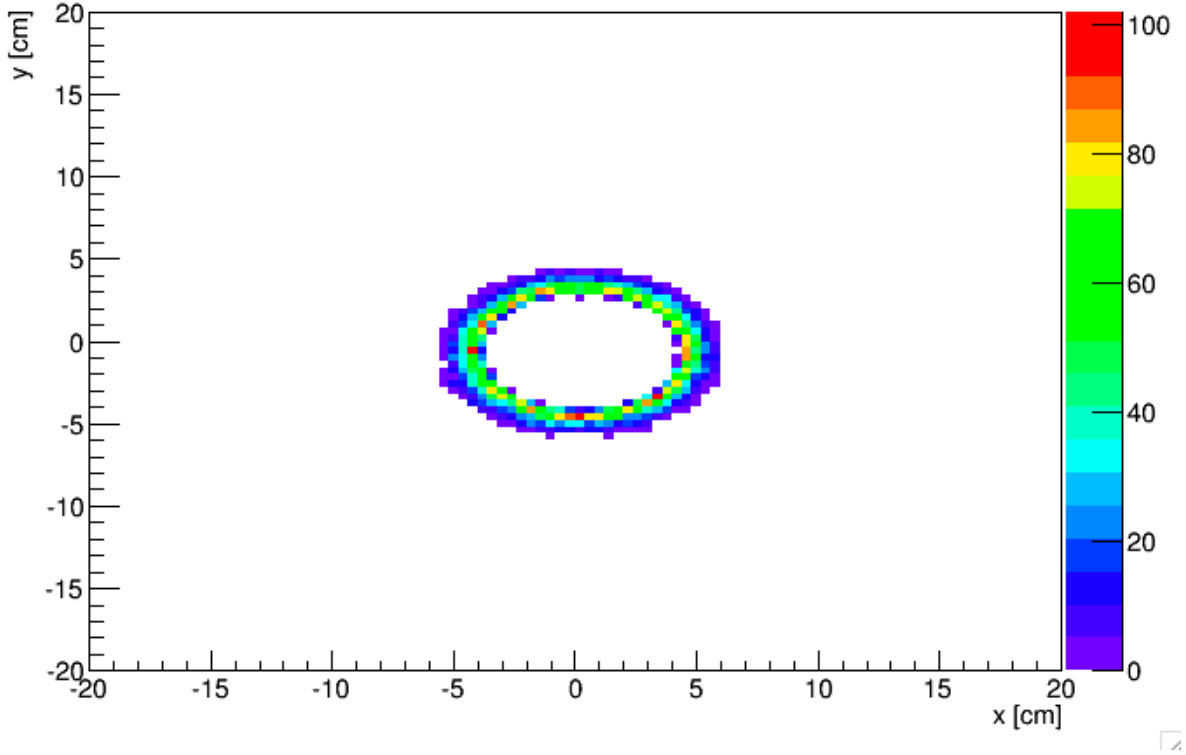


Updated acceptance plots with v3.01 and bug fixes

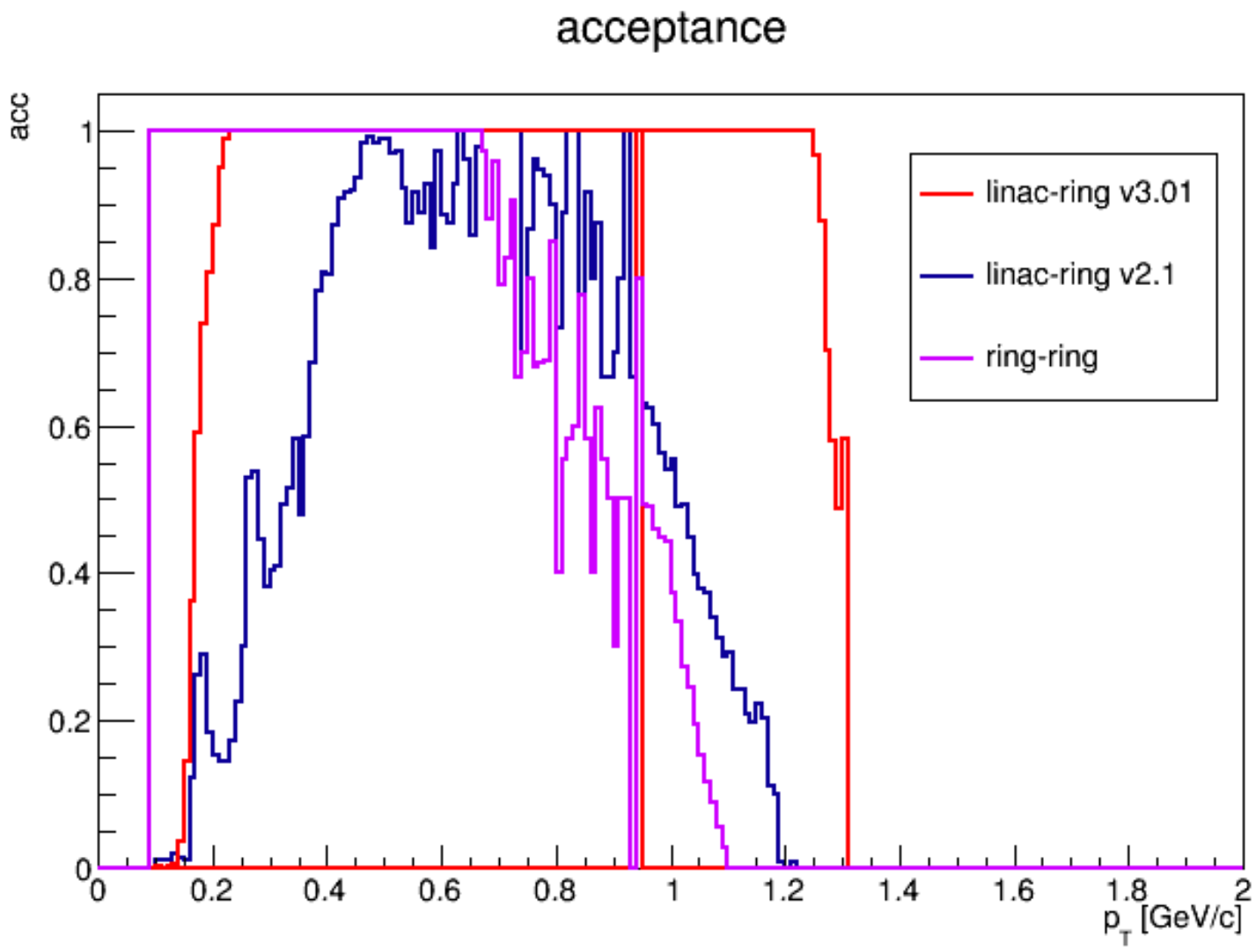
low t events ($|t| < 0.9$ GeV^2 or $p_T < 0.95$ GeV



High t events ($|t| > 0.9$ GeV^2 or $p_T > 0.95$ GeV

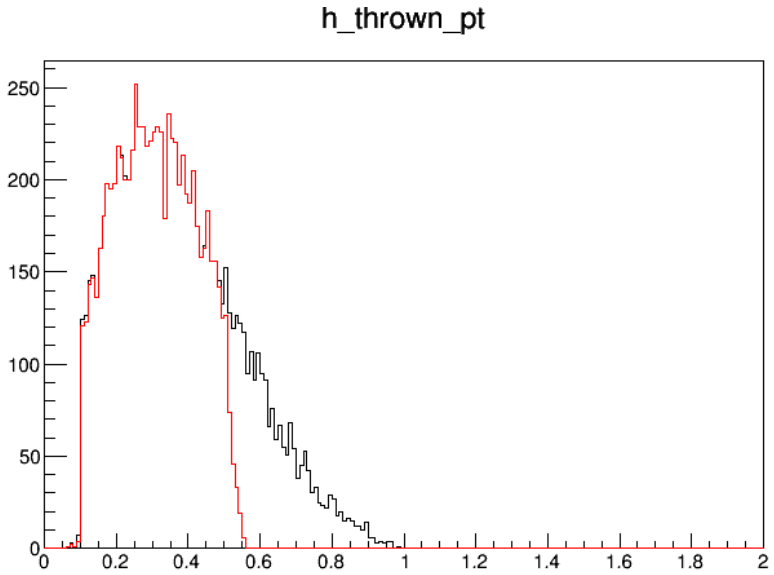


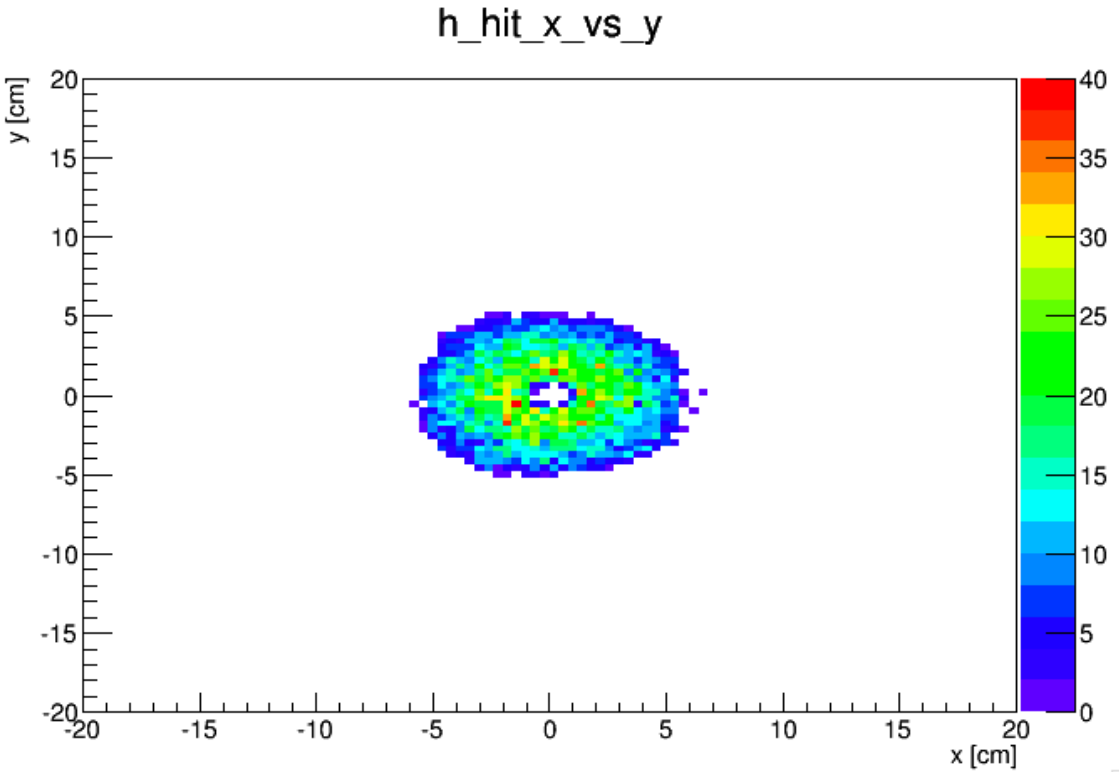
Updated acceptance with v3.01 of linac-ring

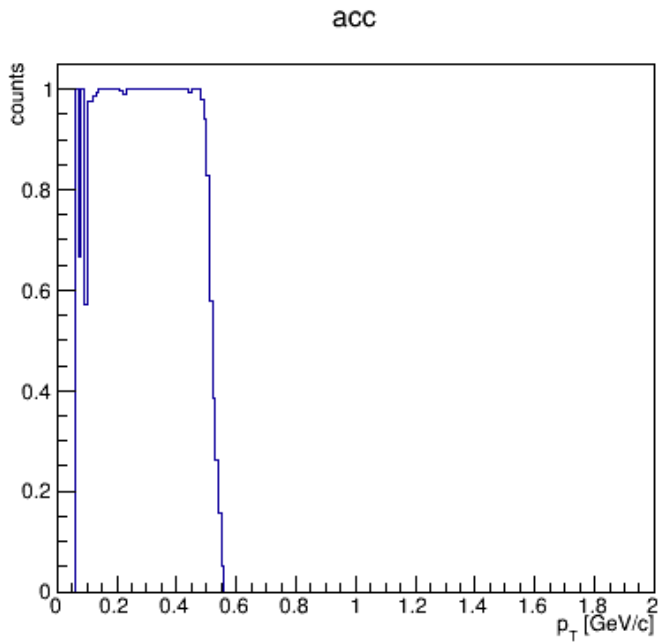


Linac-ring v3.01 acceptance for 10x100GeV collisions

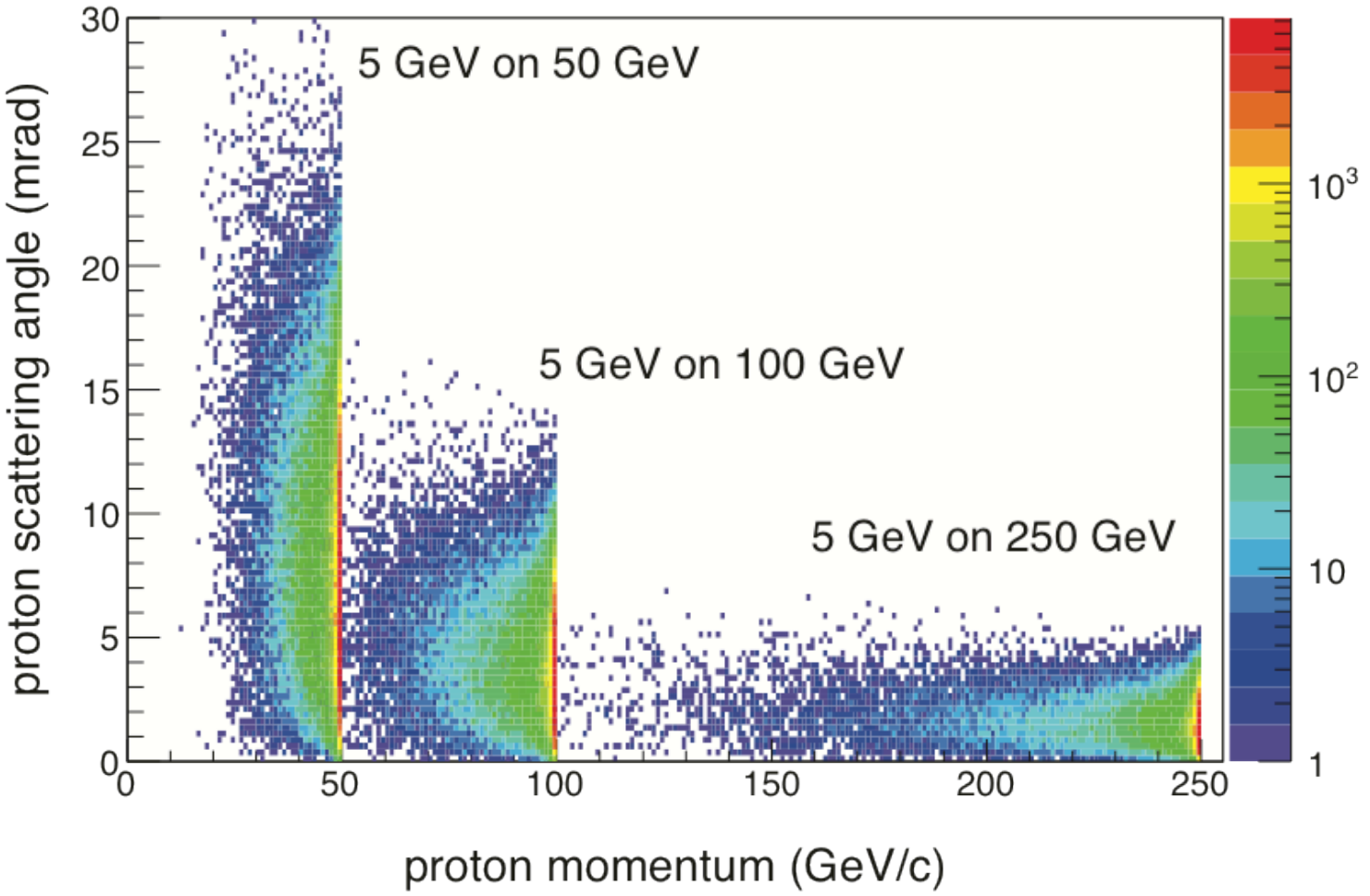
- Assumes the same beta function as for 250GeV beam







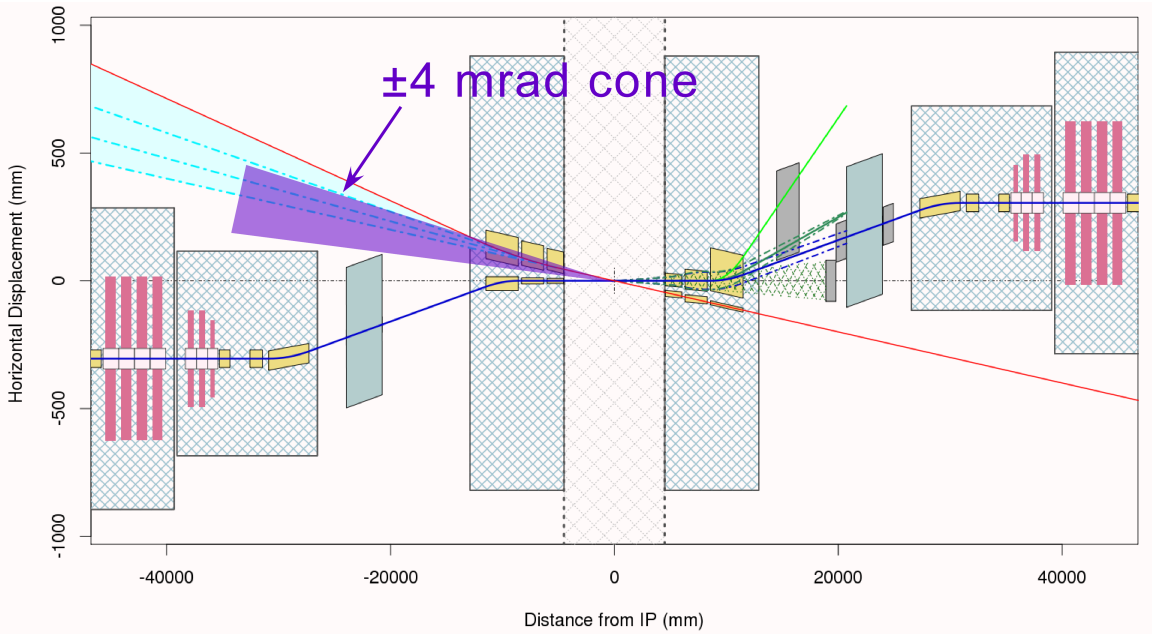
Particle distribution from DVCS as a function of beam energy

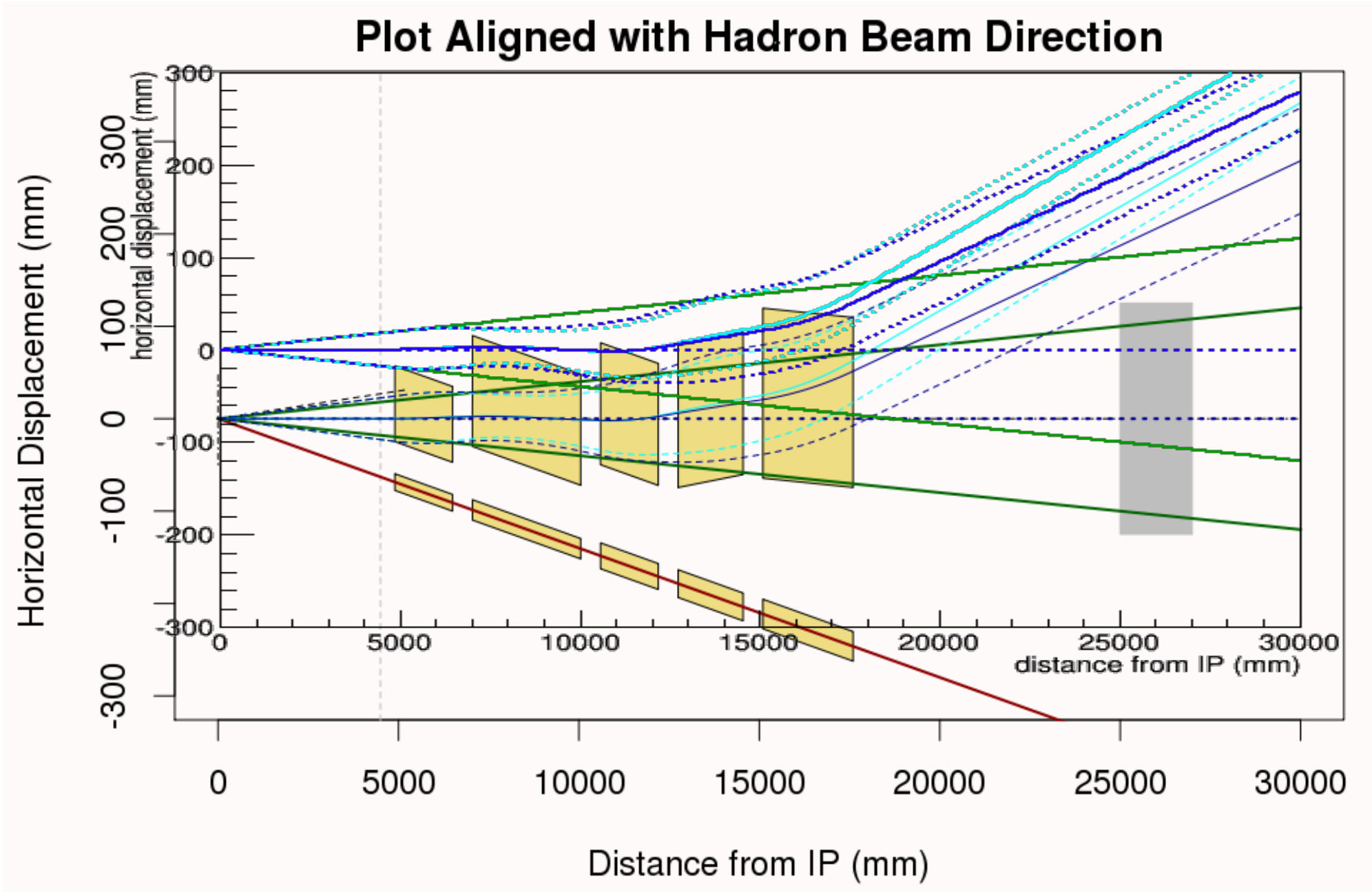


Summary

- Ring-ring design does the best at low pT
  - Smallest beta function at the roman pot location, so roman pot can be placed very close to beam
- But ring-ring does the worst at high pT
- Linac-ring v3.01 is much improved from v2.1 and is nearly perfect
- To Do:
  - Look at the real edge of the acceptance in |t|
    - Generated new MILOU DVCS events with $1.2 < |t| < 2.0$ GeV^2
    - Currently processing through EicRoot, will have plots soon

Backups


±4 mrad cone
Horizontal Displacement (mm)
1000
500
0
-500
-1000
-40000
-20000
0
20000
40000
Distance from IP (mm)


Plot Aligned with Hadron Beam Direction
Horizontal Displacement (mm)
horizontal displacement (mm)
300
200
100
0
-100
-200
-300
0
5000
10000
15000
20000
25000
30000
distance from IP (mm)
Distance from IP (mm)